

6-12-2015

The Importance of Family Meals and Sedentary Behavior in Understanding Childhood Depression and Obesity

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Recommended Citation

DeCator, Draycen D., "The Importance of Family Meals and Sedentary Behavior in Understanding Childhood Depression and Obesity" (2015). *College of Science and Health Theses and Dissertations*. 107.
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The Importance of Family Meals and Sedentary Behavior in Understanding
Childhood Depression and Obesity

A Thesis

Presented in

Partial Fulfillment of the
Requirements for the Degree of
Master of Arts

By

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February, 2015

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Acknowledgments

I would like to express my gratitude to my thesis chair, Dr. Jocelyn Smith Carter, and my reader, Dr. Cecilia Martinez-Torteya, for their support throughout my evolving thesis project. I would also like to thank Dr. Kristin Schneider, the co-Primary Investigator for the TAP for Kids project, and her team for collecting and entering a large portion of the data used for the current study. Additionally, I would like to thank my fellow doctoral students at DePaul University for qualitative feedback throughout the process of working on this project. Finally, I would like to thank the children/adolescents and parents who participated in our research study and who were willing to share the details of their home life with myself and the other researchers conducting the TAP for Kids study.

Biography

The author was born in Grandville, Michigan, June 2, 1990. He graduated from Grandville High School, and received his Bachelor of Arts degree in Psychology from DePaul University in 2012.

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Abstract

The ongoing obesity epidemic within the United States is a problem that has received a lot of attention, but is still inadequately understood. Understanding the epidemic requires examining BMI from a larger perspective, with an ecological mindset (Rosenkranz & Dzewaltowski, 2008). A bidirectional relationship between depression and obesity, which has been found in the past, might be due to family meals. Sedentary behaviors has been linked to both outcomes, and is predicted by family meal frequency, suggesting that it may play a mediational role. In order to help clarify the relationship between depressive symptoms and obesity, a sample of 120 youth (55.8% males) between the ages of eight and 14 years old ($M = 11.90$, $SD = 1.87$) was examined. The sample was predominantly Caucasian (36.7%) and African American (33.3%). Preliminary analyses found that there were differences in the outcome variables between males and females, and between participants from the two recruitment sites. Regression analyses and Sobel tests with bootstraps were conducted to test the theoretical model, one for each mediational pathway. Evidence was found for a mediational relationship between family meal frequency and depressed mood, through sedentary behaviors (indirect effect $b = -0.04$, 95% CI [-0.11, -0.01]). No evidence was found for the same relationship but with BMI as the outcome instead of depressed mood, as the indirect effect was non-significant ($b = -0.01$, 95% CI [-0.07, 0.03]). Implications for future research and intervention development are discussed.

Introduction

The obesity epidemic in the United States has proven difficult to fully explain and address. Research attention has been given to the growing epidemic within United States youth (Centers for Disease Control and Prevention, 2012) with the hopes of reversing the trend of increasing Body Mass Indices (BMIs). One factor that has been shown to have a relationship with childhood obesity is levels of depressive symptoms (e.g., Goodman & Whitaker, 2002). However, previous findings have been inconsistent as to how and why the two are related. Family meals and sedentary behaviors have been found to predict both depressive symptoms (Eisenberg, Olson, Neumark-Sztainer, Story, & Bearinger, 2004; Schmitz et al., 2002) and BMI (Epstein et al., 1995; Hammons & Fiese, 2011), and thus provide a starting place for further exploring the links between these two outcomes. A theoretical model proposed by Rosenkranz and Dzewaltwoski (2008) further highlights the need for understanding such interconnected relationships in regards to childhood obesity.

Emotional Functioning and BMI

The relationship between depression and obesity is likely more complex than it was originally thought to be. Depressive symptoms have been found to prospectively predict high BMI (Goodman & Whitaker, 2002; Onyike, 2003; Pine, Goldstein, Wolk, & Weissman, 2001; Stunkard, Faith, & Allison, 2003). However, this finding has not always been supported (Sjöberg, Nilsson, & Leppert, 2005). Faith, Matz, and Jorge (2002) identified conflicting findings in the literature, with some studies finding that depression predicts BMI

longitudinally while others find the opposite. Further supporting the idea that the relationship between depression and obesity involves additional factors comes from Sjöberg et al. (2005), who found that depressive symptoms failed to predict obesity when environmental factors were taken into account (e.g., parent employment). Therefore, a link between BMI and depression may exist, but the relationship may be explained by contextual factors that are not always accounted for in previous studies.

Family Meals and BMI

Health-related behaviors contributing to obesity in children are complicated and multifactorial. As Rosenkranz and Dzewaltowski (2008) discuss, child dietary patterns depend on a collection of micro- and macro-level variables. In addition, they suggest these variables fall within three domains: built & natural environments (e.g., TV, video, computer equipment), socio-cultural environments (e.g., family eating patterns, family demographics), and political & economic environments (e.g., food program participation). Children are dependent on their families to provide and promote health. For example, many studies have been conducted on the topic of family influence on childhood obesity. Parental BMI is highly predictive of child BMI (Whitaker, Jarvis, Beeken, Boniface, & Wardle, 2010) and children with two parents who are overweight are at highest risk of being overweight (Magarey, Daniels, Boulton, & Cockington, 2003). Another study of health-related behaviors within a family, including three generations of African-American and Native-American families, found that several health-related behaviors (e.g., television watching, activity levels) and BMI are

consistent across generations in the same household (Polley, Spicer, Knight, & Hartley, 2005), potentially due to intergenerational transmission of health behaviors. The findings from such research suggest members within a family influence one another's health habits, and some habits may be inherited from one generation to another. Another possibility is that families may be subject to similar external pressures on health-related habits, resulting in similar lifestyles.

One way in which the relationship between family meals and BMI can be explained is through the control that parents have over the diet of their children and family meals. Specifically, parents with a higher BMI may have a diet that is relatively high in fat, which then results in a family diet that is high in fat (Fisher & Birch, 1995). Therefore, the diet, which likely played a role in the high BMI of the parent, is shared and results in a high BMI of the child, resulting in intergenerational transmission of weight status. However, sharing a high fat diet can potentially be explained by the food that is available in the home, which does not require the family to eat meals together in order for the diet to be shared. Some research has suggested that high fat diets are unlikely to be passed along if the family eats together frequently. More frequent family meals are associated with a better diet and more healthy habits (Rosenkranz & Dzewaltowski, 2008). In focus groups, parents of youth with Type 1 diabetes, and their children, reported that eating healthy was easier when the family ate together, and parents felt they had more control over the diet when the meals were as a family (Rovner et al., 2010). In addition to improving meal quality, family meals offer parents an opportunity to pass down information about healthy eating (Videon & Manning,

2003). Family meals may also offer opportunities for socio-emotional growth (Larson, Branscomb, & Wiley, 2006). Overall, family meals have been shown to be a method of passing down diet-related information to children, and the degree to which that occurs likely depends on the frequency of family meals.

Numerous studies have examined the role of family meal frequency on weight-related outcomes. Adolescents who had at least three family meals per week were more likely to be a healthy weight and were less likely to become obese over time (Hammons & Fiese, 2011; Veuglers & Fitzgerald, 2005). In two cross-sectional studies, young females who reported having fewer family meals in the past week were significantly more obese than young females who reported more frequent family meals (Fulkerson, Neumark-Sztainer, Hannan, & Story, 2008; Neumark-Sztainer, Larson, Fulkerson, Eisenberg, & Story, 2010). One study found that white participants (though not black and Hispanic) were at a reduced risk of becoming overweight if they had more frequent meals together as a family (Sen, 2006), and another found that the two were related only when demographics were uncontrolled (Utter, Scragg, Schaaf, & Mhurchu, 2008). Of note, the lack of longitudinal findings (Fulkerson et al., 2008; Neumark-Sztainer et al., 2010) and the non-significant findings when controlling for demographics (Utter et al., 2008) suggest that there may be developmental differences in this relationship. Indeed, adolescents have been found to have less frequent family meals than children (Utter et al., 2008). Therefore, family meal frequency is likely related to childhood BMI, though other factors may become more important as children develop.

Family Meals and Emotional Functioning

In addition to a healthy weight, family meals are associated with better mental health. They are negatively associated with depressive symptoms (Eisenberg et al., 2004; Neumark-Sztainer et al., 2010). The reduced likelihood of having depressive symptoms may be due to socioemotional development that is facilitated by positive family meal experiences, as Larson et al. (2006) suggest in their multidisciplinary review of family mealtime function literature.

Social/emotional development might be the reason why family meals are also related to less frequent high-risk behaviors, such as violence (Fulkerson et al., 2006) and suicidality (Eisenberg et al., 2004). This social/emotional development could also explain why family meals have been associated with increased family cohesion over a period of approximately 7 years with a sample of Caucasian and African American girls (Franko, Thompson, Affenito, Barton, & Striegel-Moore, 2008). Family cohesion also predicts fewer depressive symptoms in diverse samples (Fulkerson, Strauss, Neumark-Sztainer, Story, & Boutelle, 2007).

Sedentary Behavior

Relation to BMI. The impact of family meals on depressive symptoms and BMI might be mediated through other factors. Though sedentary behavior is conceptually related to physical activity, research has suggested that these are distinct constructs (Biddle, Gorely, & Stensel, 2004). Although there is a correlation between sedentary behaviors and physical activity levels (e.g., Ussher, Owen, Cook, & Whincup, 2007), not all studies have found such a relationship (e.g., Biddle et al., 2004; Rey-López, Vicente-Rodriguez, Bosca, & Moreno,

2008). Because of these mixed findings, sedentary behaviors have been examined separately from physical activity levels in several studies. Sedentary behaviors, which include watching television (TV), reading, computer use, and playing non-active videogames, have been linked to an increase in youth BMI (Anderson, Crespo, & Bartlett, 1998; Berkey et al., 2000; Mitchell, Pate, Beets, & Nader, 2013; Patrick et al., 2004; Swinburn & Shelly, 2008; Utter, Neumark-Sztainer, Jeffery, & Story, 2003). Children who spend more than 2–3 hours per day on the computer or watching TV have corresponding increases in BMI (Arluk, Branch, Swain, & Dowling, 2003). Decreasing sedentary behavior has been found to reduce rates of overweight in youth either just as well as increasing physical activity (Epstein, Paluch, Gordy, & Dorn, 2000), or even better than focusing on physical activity levels (Epstein et al., 1995). Results are not always consistent when using sedentary behavior to predict BMI (Mitchell et al., 2013), though the evidence for a connection is strong.

Relation to depressive symptoms. Depressive symptoms have been linked to both increased sedentary behavior (Schmitz et al., 2002) and reduced physical activity (Biddle et al., 2004; Sallis, Prochaska, & Taylor, 2000). Schmitz et al. (2002) found that depressive symptoms were associated with sedentary behavior in a sample of 11–15 year old youth (predominantly Caucasian), though not with physical activity levels. Therefore, sedentary behaviors may be a reliable predictor of depressed mood.

Relation to family meals. More frequent family meals predict lower levels of sedentary activity. Yuasa et al. (2008) found that family meals were

associated with reduced sedentary activities for girls (but not boys). Gingold, Simon, and Schoendorf (2014) found that less frequent family meals (≤ 3 meals per week) was associated with greater odds of having >2 hours of screen time per day. In addition, Salmon, Timperio, Telfor, Carver, and Crawford (2005) linked a ban on watching TV during family meals to a reduced likelihood of a child watching two or more hours of TV per day.

Conceptually, this relationship between family meals and sedentary behavior is similar to the one found for family meals and BMI. Rosenkranz and Dziewaltowski (2008) include sedentary activities within their theoretical micro-level systems that influence child diet quality. Family meals provide an opportunity for families to come together and for parents to encourage their children to engage in healthier behavior. Higher levels of family functioning, which was associated with more frequent family meals, predicted healthier behaviors including lower levels of sedentary behaviors (Berge, Wall, Larson, Loth, & Neumark-Sztainer, 2013). In previous studies parents and youth not only highlighted family meals as important for communication (Fulkerson, Neumark-Sztainer, & Story, 2006; Fulkerson, Story, Neumark-Sztainer, & Rydell, 2008), but reported in focus groups that family meals allow teaching of skills such as manners (Rovner et al., 2010) and vocabulary use (Story & Neumark-Sztainer, 2005), which suggests that family meals are indeed used for providing information to youth that may include healthy habits beyond diet. However, the exact nature of the relationship between family meals and sedentary behaviors is

not fully understood. Although the two are theoretically related, having an explicit test of their relationship will help to guide further research in this area.

Because of the theoretical relationship between sedentary behavior and family meals, as well as from sedentary behavior to depressive symptoms and BMI, sedentary behavior is a potential mediator between the three. Identifying such a mediator is important for the creation of interventions to decrease BMI. By understanding the overall model, it becomes easier to tailor interventions to address as many relevant factors as possible, theoretically increasing the effectiveness and efficiency of an intervention.

Summary

Many research studies have been conducted on youth in relation to obesity. A frequent finding is that depressive symptoms and obesity are related, though mixed findings highlight the need for understanding the relationship in more detail. Family meals have been found to correlate with both depressive symptoms and BMI in several studies, providing a potential explanation for how mental health and obesity become associated. Sedentary behaviors also predict both outcomes, and family meals have been suggested to predict sedentary behavior, suggesting that mediation may also be present. The current study seeks to test this model (Figure 1) to help increase our understanding of the mechanisms involved in the association between depressive symptoms and BMI. The findings will help to guide further research, and to inform the creation of interventions for reducing depression and/or obesity in youth.

Hypotheses

Hypothesis 1: Time spent on sedentary tasks will mediate the relation between family meals and depressed mood.

Hypothesis 1a: Frequency of family meals will negatively predict time spent on sedentary tasks.

Hypothesis 1b: Time spent on sedentary tasks will positively predict level of depressed mood.

Hypothesis 2: Time spent on sedentary tasks will mediate the relation between family meals and BMI.

Hypothesis 2a: Time spent on sedentary tasks will positively predict BMI.

Hypothesis 3: BMI and depressed mood will be significantly correlated with each other.

Method

Research Participants

The current study was conducted using data from an ongoing study: The Active Project (TAP) for Kids. TAP is a study being conducted by DePaul University and Rosalind Franklin University, with the goal of increasing the likelihood that children will play active videogames that promote physical activity. To date, 120 youth from the greater Chicago, Illinois area have participated in the study. Ages of participants ranged from eight to 14 years old (Figure 2), with most participants falling into the 11–14 age range (74%; $M = 11.90$, $SD = 1.87$). The gender split of the sample was relatively equal (55.8% males). Most participants were Caucasian (36.7%) or African American (33.3%),

with the other participants identifying as Asian/Pacific Islander, Hispanic/Latino, Multi-ethnic, or Other (Figure 3). A total of 31.96% of the sample fell into the obese weight-status category based on BMI, which is higher than the national estimate of 17.7%–20.5% of youth between the ages of six and 19 in 2011–2012 (National Center for Health Statistics, 2013), but close to the estimate of 29.2% of sixth graders in Chicago Public Schools in 2010–2011 (Chicago Department of Health, 2013).

Procedures

Participants were recruited through various venues throughout the greater Chicago area (e.g., private schools, churches, community centers). Flyers about the study were posted, or research staff were stationed on-location to discuss the study with families. Interested parents and children called the research number or spoke with research staff in-person to determine their eligibility. If eligible, the participants then completed the study on-site, or they were scheduled for an appointment at one of the participating universities. During participation, parents and their children first reviewed the assent and consent forms. Once they agreed to take part in the study, participants completed a series of questionnaires either on paper or on a tablet device (via REDCap; Harris et al., 2009). Once finished with the questionnaires, their height and weight were measured multiple times. Both the parent and the child were reimbursed with a \$20 gift card to the store of their choice.

Measures

Frequency of family meals. Participants were asked to complete the Child Health & Related Behaviors questionnaire, which was taken from the Project F-EAT survey (Bauer, Hearst, Escoto, Berge, & Neumark-Sztainer, 2012; Berge et al., 2012; Bruening, MacLehose, Loth, Story, & Neumark-Sztainer, 2012). As part of this questionnaire, parents were asked: “During the past seven days, how many times did all, or most, of your family living in your house eat a meal together?” Answers were given along a six-point scale, ranging from “Never” to “More than 7 times.” This variable alone was used to represent the frequency of family meals in the current analyses.

Sedentary behavior. Participants were asked to rate the average amount of time they spend on three different sedentary activities: watching TV/DVDs/videos, using a computer (not for homework), and playing electronic games while sitting. These behaviors are similar to what other studies have used to determine levels of sedentary activity in youth (e.g., Berkey et al., 2000; Pearson & Biddle, 2011). The participants were asked to rate how much time they spend, on average, for each activity both on weekdays and on weekend days. Responses were on a seven-point scale ranging from “0 hours” to “5+ hours.” In order to calculate a total sedentary behavior score, the time spent on each activity was summed separately for weekdays and weekends. The average weekday time was then multiplied by five, the average weekend day multiplied by two, and the two values were added together, providing a total number of hours spent on sedentary activities per week. This procedure is similar to other studies that have looking at sedentary behaviors (Bryant, Lucove, Evenson, & Marshall, 2007). Of

note, validity of child-report can be questionable, including when looking at sedentary behaviors. Very little research has been done to validate measures of TV viewing and other sedentary behaviors, though child-reports have been found to have good test-retest reliability in many studies (Bryant et al., 2007). Further study is warranted once a more empirically-supported assessment of sedentary behaviors is created.

Depressed mood. Depressed mood levels were assessed using the Early Adolescent Temperament Questionnaire – Revised (EATQ–R; Rothbart, Ellis, Rosario Rueda, & Posner, 2003). Participants were asked to state how true a series of 65 statements was for them (ranging on a five-point scale from “Almost always untrue” to “Almost always true”). The measure is designed to estimate various components of a child’s temperament, including activation control, activity level, affiliation, attention, fear, frustration, high intensity pleasure, inhibitory control, perceptual sensitivity, pleasure sensitivity, and shyness. In addition, the measure includes two behavioral scales: aggression and depressive mood. For the current study, only the depressive mood behavioral scale was utilized. Scores were calculated by reversing an item (“I feel pretty happy most of the day”) and taking the mean of the associated items (six in total: the reversed item, “My friends seem to enjoy themselves more than I do,” “It often takes very little to make me feel like crying,” “I get sad more than other people realize,” “I get sad when a lot of things are going wrong,” “I feel sad even when I should be enjoying myself, like at Christmas or on a trip”), according to the scoring criteria provided by the authors. For the current sample, internal consistency was

relatively low ($\alpha = 0.65$). The EATQ–R has not been used frequently to assess depressed mood, so it is unclear how it compares to other measures of depressive symptoms.

BMIz. Body Mass Index (BMI) is the most common measurement of weight status due to its ease of calculation and ability to be adjusted for age and gender based on growth charts. The value is calculated by weight (in kilograms) divided by height (in meters), then squaring the result. All participants were measured twice in inches with the use of a stadiometer, and the values were averaged to determine the final height. Weight was measured twice in pounds for each participant on separate scales (made by BalanceFrom, Model# B00A8SLH8I), and a third measurement was taken if the weight differed by two pounds or more. The weights were then averaged to determine the final value. An Excel spreadsheet was then used to enter the height, weight, age, and sex of each participant to determine the BMI and BMI z-scores (BMIz) based on the CDC's growth chart values (Kuczmarski et al., 2000). BMIz scores are standardized, making them ideal for comparison between males and females of various ages, especially at a single time point (Cole, Faith, Pietrobelli, & Heo, 2005).

Data Analytic Strategy

All analyses were conducted using SPSS version 22 (IBM Corp., 2013). Before conducting the regression analyses, the variables of interest were assessed for correlations with one another. Partial correlations were conducted controlling for age to help reduce the effect of developmental differences. In order to test for group differences, a Multivariate Analysis of Variance (MANOVA) was

conducted, with agency (i.e., DePaul or Rosalind Franklin, as a proxy for location/environment), sex, and ethnicity (specifically, Caucasian and African American) as groups and all of the model variables (i.e., frequency of family meals, sedentary behavior, depressive symptoms, BMIz) as dependent variables. Age was controlled for in the comparisons.

Regression analyses were then conducted to test for mediation, first following the recommendations of Baron and Kenny (1986) and then through the use of a Sobel test (Preacher & Hayes, 2008) to directly test indirect effects, which has been found to have greater statistical power than the Baron and Kenny method (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Two primary regression analyses were conducted separately, one for each mediational pathway. Each regression analysis was hierarchical with control variables entered in the first step, the independent variable (family meal frequency) entered in the second step, and the mediator (average time spent sedentary) entered in the third step. All regression analyses controlled for age, sex, ethnicity, and site of participation. For the initial hierarchical regressions, a significant direct effect from the independent variable to the dependent variable (c path) was expected. In addition, independent significant direct effects were expected from the independent variable to the mediator (a path), and from the mediator to the dependent variable (b path). After adding the mediator (i.e., average time spent sedentary) to the model containing the independent variable, a change in the direct effect from the independent variable to the dependent variable (c' path) was expected to result in a non-significant relationship. This patterns would suggest full mediation, as indicated

by Baron and Kenny (1986). For the Sobel tests, bootstraps with 1000 iterations were conducted, and the confidence intervals of the indirect effects were examined for evidence of significance.

Results

Preliminary Analyses

Of the 120 total children included in the research study, complete data for all relevant variables was available for only 96. Analyses were conducted to determine if completers versus non-completers differed by sex, age, or site of participation. Chi-square analyses showed that there was no difference between the groups in regards to sex ($\chi^2(1) = 0.33, ns$), while the groups approached a significant difference in regards to site of participation ($\chi^2(1) = 3.77, p = 0.052$). An independent samples t-test was conducted to compare the groups by age, and a significant difference was found ($t(111) = 3.60, p < .001$). The age of participants who had incomplete data ($M = 10.47$) was lower than those who had complete data ($M = 12.16$). Younger participants may have had more difficulty understanding some of the questions being asked, which may have resulted in them skipping questions.

Average time spent on sedentary activities was found to significantly correlate with depressed mood ($r = 0.22, p < .05$). Number of family meals eaten in the past week was found to significantly correlate with time spent on sedentary behaviors ($r = -0.31, p < .01$) and BMIz ($r = -0.21, p < .05$), but not with depressed mood ($r = 0.07, ns$). Although the correlation between sedentary behavior and BMIz was non-significant, there were enough correlations among

the variables of interest to warrant further testing of the relationships. All correlations are summarized in Table 1. Descriptive statistics of all variables included in the analyses are reported in Table 2.

Between the two locations (i.e., North Chicago for Rosalind Franklin participants, Central Chicago for DePaul University participants), a significant difference was found for frequency of family meals, with North Chicago families ($M = 4.27$) having more meals during the past week than those located in the city of Chicago ($M = 3.49$; $F(1, 92) = 6.54, p < .05$). Differences were also found between males ($n = 58$) and females ($n = 38$). For sedentary behavior, males ($M = 47.95$ hours/week) spent more time sedentary than females ($M = 39.09$; $F(1, 92) = 4.53, p < .05$) and had higher BMIz ($M_{Males} = 1.17, M_{Females} = 0.66$; $F(1, 92) = 4.20, p < .05$). When assessing depressed mood, females ($M = 2.54$) endorsed higher depressive symptomatology than males ($M = 2.26$; $F(1, 92) = 4.00, p < .05$). This trend for higher ratings of depressed mood in females is consistent with previous literature (e.g., Grant et al., 1999), suggesting that depressed mood may represent depressive symptoms despite the low internal consistency. As a result of these group differences, follow-up analyses controlled for these variables.

Regression Analyses

The first two hypotheses were tested through the use of regression analyses, beginning with the first hypothesis (i.e., that frequency of family meals would predict depressed mood, with time spent sedentary as a mediator). When predicting depressed mood (c path), frequency of family meals was non-significant ($\beta = 0.08, ns$). When predicting average sedentary time (a path),

frequency of family meals was significant ($\beta = -0.25, p < .05$). Next, average sedentary time was found to significantly predict depressed mood (b path; $\beta = 0.31, p < .01$). The next step in the mediation model was adding the mediator, weekly sedentary time, to the equation including frequency of family meals predicting depressed mood (c` path). In this model, average weekly time spent sedentary was significant ($\beta = 0.35, p < .01$), but the frequency of family meals remained non-significant ($\beta = 0.17, ns$). The overall model accounted for approximately 16% of the variance ($R^2 = 0.16$). In the follow-up Sobel test (Figure 4), the estimated indirect effect was significant ($b = -0.04, 95\% \text{ CI } [-0.11, -0.01]$). The results suggest that frequency of family meals may only influence depressed mood indirectly through sedentary behaviors, but the relationship is not strong enough for a direct effect to be present.

Analyses then switched focus to the second hypothesis (i.e., that frequency of family meals would predict BMI, with time spent sedentary as a mediator). When predicting BMIz, frequency of family meals showed a trend towards significance (c path; $\beta = -0.18, p = 0.08$) indicating that those who engaged in more frequent family meals were more likely to have lower BMIz scores. Frequency of family meals was already determined to significantly predict time spent sedentary (a path; $\beta = -0.25, p < .05$). Time spent sedentary was found to be a non-significant predictor of BMIz (b path; $\beta = 0.10, ns$). After adding average weekly time spent sedentary (c` path), which was non-significant ($\beta = 0.05, ns$), frequency of family meals moved away from the trend towards significance ($\beta = -0.17, p = 0.13$). The overall model accounted for approximately 11% of the

variance ($R^2 = 0.11$). In the follow-up Sobel test (Figure 5), frequency of family meals again significantly predicted sedentary time ($b = -4.38, p < .01$). Despite a trend towards a significant direct effect from frequency of family meals to BMIz, the estimated indirect effect was non-significant ($b = -0.01, 95\% \text{ CI } [-0.07, 0.03]$). The results suggest that time spent sedentary does not directly predict BMIz, and family meal frequency may have a weak direct relationship.

Alternative Models

Due to the cross-sectional nature of the current study, directionality cannot be robustly demonstrated. To help determine the extent to which the results can be interpreted in the direction hypothesized, alternative analyses were conducted with pathways reversed. First, BMI was entered as a predictor of family meal frequency, with time spent sedentary as a mediator. It was found that average time spent sedentary significantly predicted frequency of family meals ($\beta = -0.27, p < .05, R^2 = 0.18$), but no other relationships were significant. Next, when the depressed mood pathway was reversed so that frequency of family meals was the outcome the analysis found that, again, average sedentary time predicted frequency of family meals ($\beta = -0.30, p < .01, R^2 = 0.18$), and all other pathways were non-significant.

In addition to reversal of the hypothesized pathways, an alternative regression was conducted to test if sedentary behaviors could be seen as an outcome rather than a mediator. Conceptually, depressed mood and high BMI could also explain high levels of sedentary behavior, alongside frequency of family meals. When all three were entered as predictors, both depressed mood (β

= 0.35, $p < .001$) and frequency of family meals ($\beta = -0.33$, $p < .01$) predicted time spent sedentary ($R^2 = 0.28$).

Finally, a regression analysis was conducted to test if depressed mood predicted BMI, with sedentary time as a mediator. Before time spent sedentary was included in the model, depressed mood was a significant predictor ($\beta = 0.20$, $p < .05$, $R^2 = 0.12$), but it became non-significant after sedentary time was added ($\beta = 0.19$, $p = 0.07$, $R^2 = 0.12$). Sedentary time was not a significant predictor. Due to the change in significance of the primary predictor with the addition of the mediator, a follow-up Sobel test was conducted. The bootstrap analysis conducted as part of the Sobel test estimated the indirect effect to be non-significant ($b = 0.02$, 95% CI [-0.06, 0.13]).

Overall, these alternative models demonstrate that specific directionality cannot be determined from the results of the current study. The primary variables may in fact have bidirectional relationships with one another, which needs to be explored further.

Discussion

Summary

The goal of the current study was to help clarify the relationship between depressive symptoms and BMI. Family meals and sedentary behavior, which have both been found to relate to depressive symptoms and BMI, were assessed as predictors. Sedentary behaviors, which is predicted by family meals, was assessed as a mediator. The results of the current study support family meals predicting depressive symptoms, fully mediated by sedentary behaviors. When predicting

BMI, the results of the current study suggest that there is a weak direct relationship from family meals to BMI, though the nature of the relationship is unclear.

Time spent on sedentary tasks mediated the relationship between family meals and depressed mood. It was hypothesized that family meals would allow parents to promote healthier habits, and to reduce the amount of time children spent on sedentary tasks. In doing so, children would be less likely to engage in behaviors that have been associated with depression. In addition, previous studies have suggested that family meals may help to improve socioemotional development (for a review, see Larson et al., 2006) which likely influences depressive symptoms.

Frequency of family meals negatively predicted time spent on sedentary tasks. This is consistent with previous research. The current study was unable to examine the mechanisms, but several possibilities exist. It may be that family meals offer parents an opportunity to teach their children about healthy habits (through modeling, structure, routines, etc.; Fiese & Jones, 2012). Alternatively, having meals together could reduce the amount of time that youth have to be sedentary. Meals, which would not count towards common definitions of sedentary behavior, may be replacing alternative behaviors such as watching TV. Future studies should examine the alternative possibilities.

Time spent on sedentary tasks positively predicted depressed mood. This finding supports previous literature, which has also found a relationship between sedentary behaviors and depressed mood (Schmitz et al., 2002). However, due to

the cross-sectional nature of the study the directionality of the relationship is still unclear. Depressed mood is associated with anhedonia and fatigue, which would likely result in increased sedentary behavior (Calamaro & Waite, 2009). Yet, sedentary behavior may also be responsible for increases in depressed mood. Previous research shows that physical activity acts on dopamine pathways (Southwick, Vythilingam, & Charney, 2005). Overall, the current study highlights a link between the two variables, but the directionality needs to be further assessed in longitudinal studies.

Time spent on sedentary tasks did not mediate the relationship between family meals and BMIz. A test of indirect effect was non-significant. The mediational pathway may not be significant alone, but it is likely part of a larger system of relationships. As Rosenkranz et al. (2008) discuss, factors related to child dietary intake are multi-faceted and multi-systemic. There are many additional factors that contribute to BMI, such as food landscape and community economic conditions (Rosenkranz et al., 2008). Future studies should seek to examine the relationship between family meals and BMIz more thoroughly while accounting for these other systemic factors.

In contrast to our expectations, time spent on sedentary tasks did not predict BMI. Previous research on this association has been mixed, with one study finding different relationships among different racial groups (Lowry, Wechsler, Galuska, Fulton, & Kann, 2002). One reason for the lack of this finding could be that physical activity levels were not taken into account. Sedentary behaviors and physical activity are separate constructs (Biddle et al., 2004), so high sedentary

levels in the current study do not necessarily correspond to low physical activity levels. In addition, sedentary behavior is just one factor that has been found to predict BMI, but other factors such as diet quality are also implicated (Rosenkranz & Dzewaltowski, 2008). Because these other factors were not included in the analyses, sedentary behavior alone may have simply been insufficient to explain BMI.

Finally, depressed mood and BMIz were not significantly correlated with each other in straight correlation analyses. However, a relationship has been found in previous studies (e.g., Goodman & Whitaker, 2002). Therefore, a more thorough examination of the direct relationship between these two variables, that is longitudinal and takes into account developmental factors, may help to clarify the relationship.

Although the findings of the current study are preliminary, there is initial evidence that frequency of family meals can help to explain depressed mood, with time spent on sedentary tasks as a mediator. There is also weak initial evidence for a direct relationship between family meals and BMI, which warrants further inspection. Professionals developing interventions to target depressed mood and/or BMI may want to target sedentary behaviors and the frequency of family meals. There is a lack of literature on the effectiveness of any formal programs to increase the frequency of family meals, though other researchers have also recommended that family meals be targeted by new interventions (Fulkerson, Larson, Horning, Neumark-Sztainer, 2014). By increasing the frequency of family meals, the other outcomes may improve without needing direct intervention.

However, there is currently insufficient support to suggest that targeting family meal frequency alone will be enough to result in meaningful changes in depressed mood and BMI. Therefore, intervention providers should consider adding a family meal component to current interventions, rather than making it the sole focus of the intervention.

Limitations

Several limitations of the current study provide directions for further research. First, tests of mediation need to be conducted longitudinally in order to be robust (Maxwell & Cole, 2007), so the cross-sectional nature of the current study means that the mediation evidence is only preliminary. Ideally, three time points are needed in a future study, with family meal frequency at time 1 predicting sedentary behaviors at time 2, and the sedentary behaviors then predicting depressed mood and BMI at time 3. The current study acts as a first step in developing a more robust model in the future. In addition, by testing alternative directions of effects the current study highlights the relationship between the variables in the model, but fully demonstrates that the exact directionality is uncertain.

Second, the sample was limited to urban youth in the Midwest of the United States, and consequently the results may not generalize to other populations, especially due to the overrepresentation of Caucasian and African American youth. Future studies with a national sample are needed in order to determine if the findings are generalizable to United States youth. International studies are also needed in order to see if the same relationships exist outside of the

United States. Such studies will also be able to replicate our analyses with a larger sample, which will help to increase the sensitivity. Such replication is needed due to the limited sample size of the current study.

Finally, some of the variables used in the current study have questionable validity. Depressed mood, as estimated by the EATQ-R, had low internal consistency and little prior research to demonstrate the psychometrics of the subscale. In addition, although child-report of sedentary behavior has been found to be valid in several studies, the current measure of sedentary behaviors was not fully assessed for validity as has been recommended by others (Bryant et al., 2007). The results of the current study need to be replicated with measures that have established psychometrics.

Strengths

Despite the limitations noted above, the current study has several strengths. First, it tested relationships to depressive symptoms and BMI to a greater extent than previous studies, helping to highlight the fact that additional factors need to be assessed. Second, the current study demonstrates the multifaceted utility and benefits of family meals, which has been linked to diet quality, but not other social-emotional and behavioral factors, in previous studies. Finally, the current study demonstrates that sedentary behaviors may act as a mediational mechanism between various health-related factors, highlighting the need to address sedentary behaviors and providing evidence for how to do so.

Future Directions

Based on the results of the current study, and the limitations discussed above, suggestions for future studies can be made. First, the mediational pathways identified in the current study should be examined longitudinally and with a larger sample to help provide more robust evidence for whether or not mediation is actually occurring between these variables. Second, frequency of family meals may represent one piece of a larger factor (e.g., family cohesion, family functioning) which may be a better predictor of health-related behaviors than family meals. Similarly, other factors not included in the model may help to further explain the relationships among the variables in the current study. For example, a lack of access to healthy foods may prevent a family from eating healthy even if they eat meals together frequently. There may also be cultural differences that alter the likelihood that family meals will result in a healthier diet, which warrants further study (Patrick & Nicklas, 2005). Finally, the relationship between sedentary behaviors and physical activity and the extent each acts as a mediator is worth examining. Although previous studies have found sedentary behavior to be the more strongly related to BMI (Epstein et al., 1995), the non-significant relationships with BMI in the current study may have been partially due to the exclusion of physical activity from the model (which has recently been found to be more predictive of BMI than sedentary behaviors; Chaput et al., 2012). Thus, future studies should incorporate sedentary and active behaviors, while accounting for any relation between the two, in order to determine the independent and indirect effects each has on BMI.

Conclusion

Health-related behaviors are a product of many different variables in several different settings, as illustrated by Rosenkranz and Dzewaltowski (2008). In order to better understand the outcomes we see, it is important to have a better understanding of how external factors and personal behaviors relate to one another. The current study contributes to the understanding of these systemic interactions, and paves the way for further research and more efficient interventions.

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Table 1

Partial correlations among variables

Variables	1	2	3	4
1. Family meal frequency	--			
2. Average sedentary time	-0.31**	--		
3. Depressed mood	0.15	0.22*	--	
4. BMIz	-0.21*	0.14	0.15	--

Note. * $p < .05$; ** $p < .01$. $N = 107$. Controlling for age.

Table 2

Descriptive statistics for variables

Variables	Mean	<i>SD</i>
Family meal frequency (meals/week)	3.95	1.43
Average sedentary time (hours/week)	44.46	23.56
Depressed mood	2.42	0.67
BMIz	0.95	1.08

Table 3

Regression analysis results when predicting depressed mood

Variables	Step 1	Step 2	Step 3
Age	0.06	0.07	0.02
Sex	-0.23*	-0.22*	-0.28*
Ethnicity	0.05	0.07	0.11
Site	0.17	0.07	0.05
Family meal frequency	--	0.08	0.17
Average sedentary time	--	--	0.35**

Note. * $p < .05$; ** $p < .01$. $N = 105$. $R^2 = 0.16$. All values are standardized beta coefficients.

Table 4

Regression analysis results when predicting BMIz

Variables	Step 1	Step 2	Step 3
Age	0.17	0.16	0.16
Sex	0.19 [†]	0.19 [†]	0.18
Ethnicity	0.08	0.11	0.12
Site	0.22	0.18	0.18
Family meal frequency	--	-0.18 [†]	-0.17
Average sedentary time	--	--	0.05

Note. [†] = Trend towards significance. $N = 105$. $R^2 = 0.11$. All values are standardized

beta coefficients.

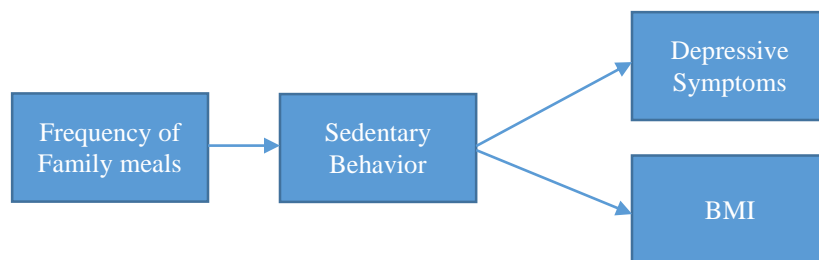


Figure 1. Conceptual path model of hypothesized relationships.

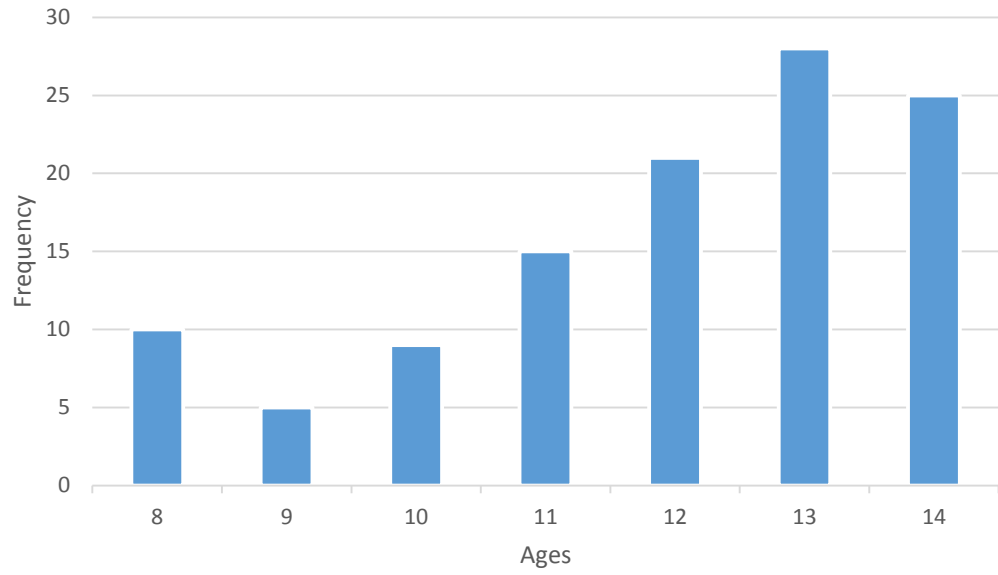


Figure 2. Age demographics of sample.

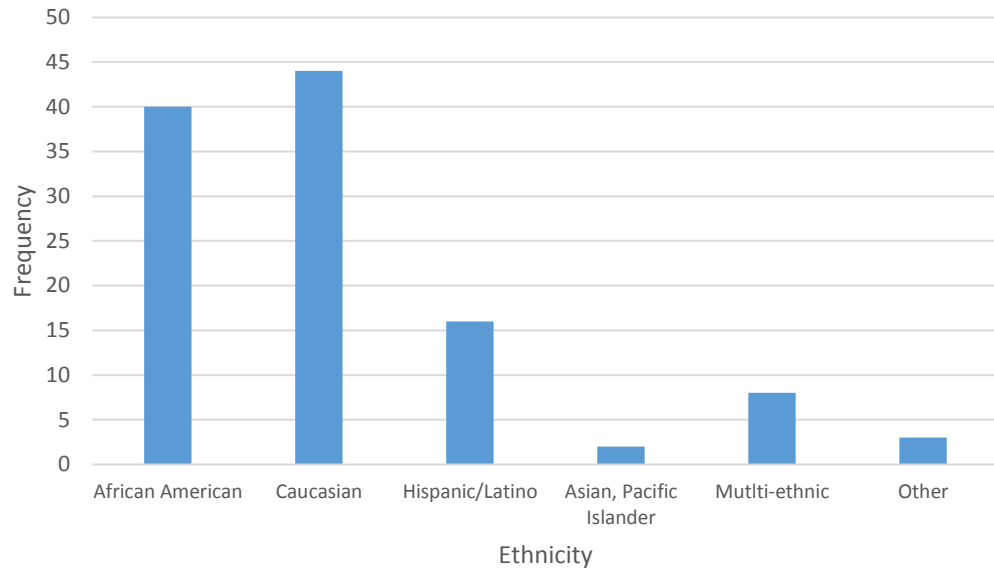


Figure 3. Ethnicity demographics of sample.

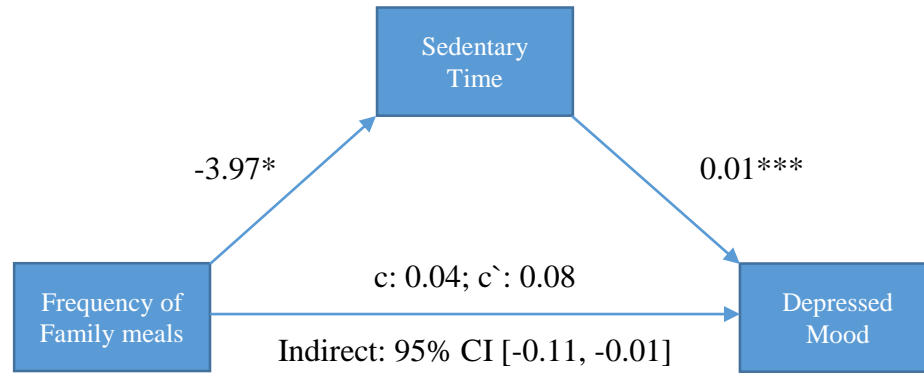


Figure 4. Results from Sobel test with bootstrap, predicting depressed mood. Controlling for age, sex, ethnicity, and site.

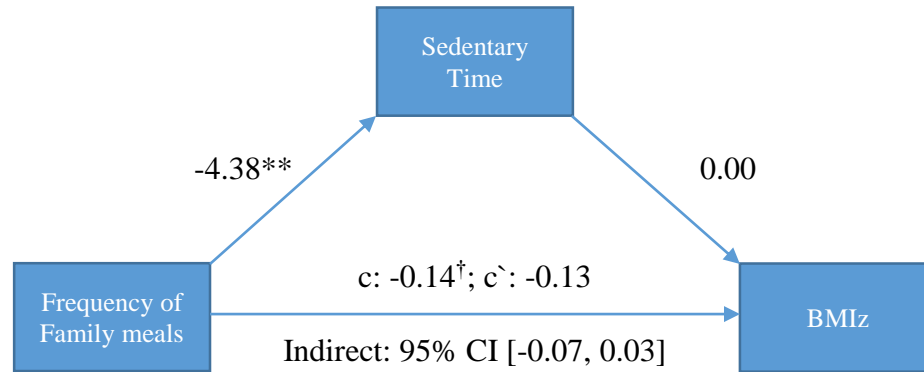


Figure 5. Results from Sobel test with bootstrap, predicting BMIz. Controlling for age, sex, ethnicity, and site. \dagger = Trending towards significance.